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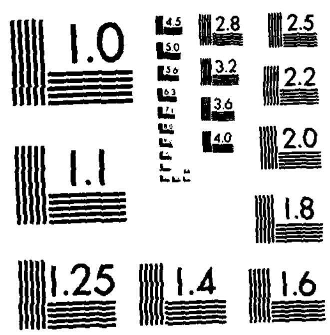

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OPTICAL STORAGE TECHNOLOGY FOR MAPPING

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ABSTRACT

The paper map has long been a great service to man. But today, some map users find the paper map to be an inadequate tool for the job at hand. Problems with paper maps range from storage of large quantities of maps to deterioration and deformation with age. Optical disc technology can be used with the data already available on paper maps to provide a solution to some of these problems, as well as provide additional flexibility not found on the paper map.

The limitations and expectations of each type of optical disc system pertaining to its use in the cartographic field need amplification. Much of this technology is changing as research teams are quickly discovering new capabilities and applications for optical disc systems. Applications in the mapping industry offer exciting changes to traditional forms of map use and provide the map user with an entire range of new ideas.

INTRODUCTION

The paper map historically has been the preferred media for the storage and transfer of cartographic data. The simple conveniences of paper maps will make them a viable product for many years hence. Today, however, rapid demands for large numbers of maps and charts have limited the usefulness of the paper map. The storage of geographic information in this form requires large numbers of map cabinets and retrieval of the information can be a time-consuming process. Current cartographic research is directed to exploring alternative media for the storage and display of map data. Optical storage technology is one possible solution. It provides a solution to the problems of storage and retrieval of data, and when combined with computer technology has capabilities not yet available to users of paper maps.

Currently, there are two forms of data input for

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optical storage media: analog and digital. The video disc is an analog format medium, read by laser. The optical disc is a digital format medium, also read by laser. This distinction can be further broken down to systems for each format that are capable of only reading information from the media or systems that can read and write information on the media. This breakdown is analogous to cassette players which can only play tapes, or cassette recorders that can play and record tapes. Presently, only non-erasable media are available commercially, but some companies are making progress toward development of some erasable media. Some features common to optical storage systems are extremely large data storage (up to 10 gigabytes for digital discs or 108,000 still frames for video discs) and fast data retrieval (any track on a disc may be accessed in three seconds or less). Jukebox-type systems also are available which give quick access to any disc stored in the system. Attractive features of optical discs include their use of the latest technology, compactness, resistance to abuse, and computer compatibility (digital disc drives).

There are many examples of optical storage media use in the world today. The Library of Congress, which has a storage requirement of over eighty million documents, uses a jukebox-type optical disc system to store literature at a projected savings of four cents per printed page compared to their former storage system that used microfilm. The Phillips Company has put out a new optical disc storage and retrieval system called Megadoc for office automation needs which uses optical discs. The system employs a digitizer that creates digital data from printed materials to be stored on an optical disc by methods of optical scanning. This system stores sixty-four optical discs at two gigabytes per disc and can retrieve any disc within eighteen seconds and locate any track on a disc within two seconds. These examples show the incredible storage capabilities offered by optical storage technology which can be applied to mapping. A look at each type of optical storage media will make evident the limitations and capabilities of each for cartographic uses.

ANALOG OPTICAL MEDIA

The most common optical medium is the analog video disc, the term analog implying a continuous representation of the data. The procedure for putting information on the video disc involves video taping the data (maps, charts and elevations) in order to produce the National Television Standards Committee (NTSC) signal used by the television industry. The data, now in the form of the NTSC signal, are transferred to the video disc via a high-power gas tube laser. The intensity of the signal transmitted from the video tape modulates the power of the laser. The laser in turn encodes the data onto the video disc in the form of microscopic pits approximately one micron in depth. The data, therefore, are represented on the video disc by tiny pits of constant depth that vary in length according to the intensity of the signal they represent. Information is read from the disc in a similar fashion. A low-power laser, contained within the player, tracks the disc as it

rotates, focusing light on the tiny pits. This light is reflected back from the pits with an intensity proportional to the length of each pit. A light-sensitive diode then picks up the reflected light and converts it back to standard NTSC signals which appear on the monitor as an image. The video disc with the tiny pits representing the data, though not the only type in use, is presently the most practical.

Video discs are formatted in two ways. The constant angular velocity (CAV) disc has 54,000 concentric tracks per side. The constant linear velocity (CLV) disc has a continuous spiral track and allows up to one hour of motion video play. This format does not have the still frame or random access features of the CAV video disc and is of little use in mapping.

With only a limited technical background, discussion of the real applications and limitations of the video disc can be meaningful. Analog optical video disc systems have many features not found in other media. First, they have large storage capabilities. Each side of a CAV video disc can hold 54,000 still images or thirty minutes of motion video. These can be combined on a video disc to provide still and motion pictures. Secondly, video discs provide random access capabilities. This allows one to search for and locate any of the 54,000 frames in less than three seconds, although this is expected to decrease in the near future. This ability also makes video discs compatible with computers for many uses. Another important feature of CAV video disc is that it provides a homogeneous format for all types of documents. All necessary data including charts, maps, terrain elevations, and text information can be stored on the same disc. This saves space and conquers the massive confusion of trying to use and store many different sized and shaped documents. Finally, any image on a video disc can be held on the screen indefinitely without loss of clarity of the picture. This allows the user the ability to study one particular image for an extended period of time. According to the user's needs, a system can be developed that utilizes these aforementioned qualities in a way necessary to satisfy requirements. There are three levels of interactive systems. They are:

I. The "consumer" player without any processing power - such a unit plays through the video disc but does not have the capability to locate a particular track at the user's discretion.

II. The "industrial" player with built-in processing power - this unit has certain capabilities which enable the user to interact with the operations of the system through the processor.

III. Either of Levels I or II interfaced to a microcomputer - this provides the user a capability to interact with the system according to his own needs through development of appropriate software.

These features allow creation of systems using a video

disc player to suit particular needs. If a map archiving system is the desired use for the video disc then all that is needed is a Level II player with the on-board processor providing the random access capability. This would provide the user with a compact storage medium requiring little storage space, a medium which will preserve the material indefinitely without any deformation or damage to the data, and random access capability so that the desired information can be retrieved from the video disc in a short amount of time. If one requires an extremely large storage space then a jukebox-type system can be developed. This would allow the user to have several video discs of data at his control with access time being almost negligible.

Another system might be used as a map training device. This would require either a Level II player with extensive built-in processing power and a disc containing software or a Level I player interfaced with a microcomputer using appropriate software. For instance, a map reading trainer could be developed that would interact with the trainee. By developing software that utilizes branching techniques and random access capabilities of a video disc, a series of lessons, questions, and skills tests could be presented to the trainee. The trainee would interact with the system through a touch screen panel or a key board. The lessons might involve still images of cartographic data with audio instruction and moving pictures demonstrating an operation or process. By interacting with the system the trainee can answer questions and demonstrate newly learned skills.

While the video disc is popular for interactive training programs and for general image and data storage, the future for advanced optical mass data storage systems is seen in the optical (digital) disc. A discussion of optical digital disc technology will help identify possible uses and drawbacks.

DIGITAL OPTICAL MEDIA

The optical disc has much in common with the video disc with respect to the physical means of information storage. As with the video disc, data are encoded on the optical disc in the form of microscopic pits burned into the substrate by a high-power laser. The difference is in the manner of recording and interpretation of the pits. As mentioned earlier, pits on the video disc correspond to a fluctuation in the analog signal which they represent. In the case of the optical disc the pits represent the digitization of data in the form of binary code. Pits on video discs are of different lengths corresponding to the intensity of the video signal, whereas pits on the optical disc are all uniform in size with the presence or absence of a pit being read by the computer as a one or a zero.

Technically, the optical disc is a binary code storage medium capable of storing up to ten Gbytes of information. The Defense Mapping Agency Digital Terrain Elevation Data (DTED) for the landmass of the entire world could be stored on less than fifteen two-sided discs

compared to over two thousand, 2,400-foot reels, of 1,600 bit-per-inch magnetic tapes. The potential for manipulation of stored data is really where the optical disc offers its most significant advantages. For example, to zoom in on a video disc map, a command is given by the user and an enlarged photo of the same map area is accessed from the video disc. To zoom in to higher magnification an even greater enlargement of the desired area is accessed from the video disc. This means that for each magnification level designated for zooming, one has to store an appropriately enlarged photo of the desired area as a frame on the video disc. Here, zooming capabilities are limited to the number of enlarged photos that are stored. Obviously this is a severe limitation in that it wastes disc storage space. In case of the optical disc, all that is needed for zooming is digitized data of the desired area. A computer can take the binary code and magnify the image to desired levels using standard image processing techniques. On optical discs, once digitized information has been accessed from the disc, possibilities for manipulation go as far as the software and computer technology can take them.

CONCLUSION

The key point to be noted is that optical storage technology can provide many practical advantages in mapping operations and perhaps product dissemination. Current technology involved with optical storage media is new and constantly changing, creating an opportunity to apply new ideas and do things in a new way. Capabilities offered by the video disc and the optical disc both have their good points. It should be noted that both have random access and large storage capabilities which make them ideal to use with computers.

Both video disc and optical disc players can be commanded by the computer to access a specific disc track supplying the computer with information in a language that is computer-readable, thus creating the opportunity for all types of data manipulation (ditigal data on the video disc is stored as analog and must be converted back to digital format for computer use.) The main drawback of the video disc at present is the low resolution of the video display due to the NTSC format limitations.

Considering the advantages offered by optical storage technology, it is felt that both optical formats will find applications in the mapping community. It is apparent that most of the mapping community is upgrading its computer capability. Further, with many major mapping organizations' increasing commitment to upgrade to an all digital operation and produce softcopy maps, it appears likely that optical discs will serve many practical uses and provide a tool for many new applications.

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